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REMARKS

Claims 1, 2, 9, 23-26 and 29 have been amended. Claims 3, 4, 7, 8, 10-17, 28 and 30-37 have been canceled. Thus, Claims 1, 2, 5, 6, 9, 18-27, 29 and 38-42 are presented for examination. Support for the amendment to claims 1 and 23 may be found in canceled claims 4, 8 and 15-17. Thus, no new matter has been added. Reconsideration and withdrawal of the present rejections in view of the comments presented herein are respectfully requested.

Rejections under 35 U.S.C. §103(a)

Sarshar et al. (WO 95/074414) alone

Claims 1, 2, 10, 12, 17-19, 21, 23-25, 30, 32, 33, 37-39 and 40-42 were rejected under 35 U.S.C. §103(a) as being unpatentable over Sarshar et al. (WO 95/074414). Claims 10, 12, 17, 30, 32, 33 and 37 have been canceled, thus rendering the rejection moot as it applies to these claims. The rejection will be addressed as it relates to claims 1, 2, 18, 19, 21, 23-25 and 38-42.

In order for a claim to be anticipated by a reference, each element of the claim must be found within the reference. Claim 1 as amended recites the following features which were previously recited in canceled claims 4, 8 and 15-17:

- a compressor that is constructed and arranged to provide a sustainable gas source having a pressure in the range 50-150 bar;
- a cyclone-type phase separator;
- a knockout vessel for removing retained liquid from the low pressure gas phase, having an inlet connected to receive the LP gas phase from the phase separator, a LP gas outlet and a LP liquid outlet; and
- a positive displacement pump for liquids, which receives LP liquid phases from the phase separator and the knockout vessel,
- wherein the gas-gas jet pump is connected to receive the separated LP gas phase from the knockout vessel and a HP gas supply from the compressor.

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Similar amendments have been made to claim 23. These features are neither disclosed nor suggested by Sarshar et al. Specifically, Sarshar neither teaches nor suggests:

- a compressor or a sustainable gas source having a pressure in the range 50-150 bar.
- a knock-out vessel (or any other means) for removing retained liquid from the separated LP gas phase.
- a gas-gas jet pump which receives LP gas from a knock-out vessel, or HP gas from a compressor.
- a positive displacement pump
- an LP inlet connected to receive a LP liquid phase from a knock-out vessel.

Thus, the claims cannot be obvious over Sarshar et al. In addition. Applicants note that claims 4, 8, 15 and 16 were not rejected by the Examiner as being obvious over this reference alone. Thus, the pending claims are clearly patentable over this reference.

Sarshar in view of other references

The remaining obviousness rejections are based on Sarshar as a primary reference, combined with several secondary references.

Claim 3 was rejected as allegedly being unpatentable over the combination of Sarshar et al. and Ackermann et al. (US 4,762,467). Claim 3 has been cancelled herein, thus rendering this rejection moot.

Claims 11 and 31 were rejected as allegedly being unpatentable over the combination of Sarshar et al. and Appleford et al. (US 2004/0154794). Claims 11 and 31 have been cancelled herein, thus rendering this rejection moot.

Claims 15, 16, 35 and 36 were rejected as allegedly being unpatentable over the combination of Sarshar et al. and Talley (US 3,590,919). Claims 15, 16, 35 and 36 have been cancelled herein, thus rendering this rejection moot.

Claim 4 was rejected as allegedly being unpatentable over the combination of Sarshar et al. and Wiltshire et al. (GB 2 239 676).

Claims 7, 8 and 28 were rejected as allegedly being unpatentable over the combination of Sarshar et al. and Cholet et al. (US 4,718,824).

The present invention relates to a system and process for pumping multiphase fluids, and in particular for boosting the production of gas and oil from low pressure wells. The need for a production boosting system is described in detail in the introductory portion of the present specification.

The system described in Sarshar uses high pressure fluid from high pressure wells to raise the pressure of the fluids obtained from low pressure wells. The high pressure fluids are separated into high pressure gas and liquid phases using a cyclone-type separator 41. The low pressure fluids from the low pressure wells are also separated into low pressure gas and liquid phases using another cyclone-type separator 42. The high pressure gas supply is then used as the motive fluid to drive a gas-gas jet pump 32, thereby increasing the pressure of the low pressure gas supply. The high pressure liquid supply is similarly used as the motive fluid to drive a liquid-liquid jet pump 32, which increases the pressure of the low pressure liquid supply.

One of the problems associated with the system described in Sarshar is that the high pressure wells that supply the motive fluids to the jet pumps may not be sustainable in the long term. The system described in Sarshar is therefore very limited in its application.

Another problem with using high pressure wells to provide the motive fluids for the jet pumps is that the high pressure fluids from high pressure wells are usually not of uniform consistency or pressure. For example, the fluid may contain slugs of liquid and pockets of high pressure gas. When these fluids are separated large fluctuations in the pressure and quantity of the motive fluids may result. This may severely affect operation of the jet pumps.

The pressure and consistency of the fluids obtained from the low pressure wells may also fluctuate greatly. It may therefore be desirable to control the speeds of the gas and liquid pumps according to the rate at which the different fluids are drawn from the low pressure wells. However, this is not easy when the jet pumps are powered by fluids obtained from high pressure wells.

Another problem with the system described in Sarshar arises from its use of cyclone-type phase separators. Although it is desirable to use this type of separator from the point of view of cost and compactness, such separators have a relatively low efficiency and do not completely

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separate the gas and liquid phases. The gas phase emerging from a cyclone-type phase separator will therefore generally include a significant proportion of retained liquid, and the liquid phase will include some free gas. Both of these factors again severely reduce the efficiency of the jet pumps.

The presently claimed invention provides numerous unexpected advantages over the system of Sarshar, in particular by providing solutions to the problems set forth above. In the presently claimed invention, the gas-gas jet pump is driven by high pressure gas from a compressor. This gas supply is sustainable and can be controlled relatively easily according to the quantity of the gas drawn from the low pressure wells. Fluctuations in the quantity of gas drawn from the low pressure wells can thus be accommodated, ensuring efficient operation of the jet pump. Similarly, the use of a mechanical liquid pump allows the liquid pumping speed to be controlled as required, according to the quantity of the liquid drawn from the low pressure wells.

The low pressure gas phase emerging from the phase separator is delivered to a knockout vessel, which removes any retained liquids from the low pressure gas phase. This overcomes the problem of incomplete fluid separation inherent in the use of cyclone-type separators and ensures that the low pressure gas delivered to the gas-gas jet pump is essentially clean, which greatly improves the efficiency of the jet pump. The low pressure liquid removed by the knockout vessel is combined with the low pressure fluid from the phase separator and is delivered to the liquid pump.

The use of a positive displacement pump as the liquid pump also provides significant advantages, since the efficiency of a positive displacement pump is not significantly affected by the presence of some free gas in the low pressure liquid phase. This avoids the problems resulting from the use of certain other types of liquid pump, including jet pumps and some mechanical pumps (for example centrifugal pumps), which are greatly affected by the presence of free gas in the liquid.

The features introduced into claims 1 and 23 as indicated above are neither disclosed nor suggested by Sarshar. Nor is there any suggestion of the advantages provided by those features. Accordingly, the presently claimed invention is not obvious over Sarshar. The advantages

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referred to above are not disclosed or suggested by any of the cited documents, either alone or in combination.

Ackermann et al (US 4,762,467) describes a method for controlling the pressure ration of a jet pump. The jet pump system described therein is not intended specifically for pumping multiphase fluids and does not include a compressor, a cyclone-type phase separator, a knock-out vessel or a positive displacement pump...

Wiltshire et al (GB 2239676) describes a method of pumping gas/liquid mixtures in which the mixture is divided into a gas-rich portion and a gas-reduced portion using a T-shaped separator. The pressure of one of the portions is then increased with a pump (Fig. 1) or a compressor (Fig. 2), after which the two portions are recombined in an injector. There is no suggestion of using a gas-gas jet pump to increase the pressure of the gas-rich portion, or a compressor to drive a gas-gas jet pump. The system also does not include a cyclone-type phase separator, or a knock-out vessel.

Appleford et al (US 2004/0154794 A1) describes a borehole production boosting system in which the flow of production fluid is boosted at the wellbore by a down-hole jet pump, using jetting fluid as the motive fluid. The jetting fluid is then removed using a gravity separator so that only the production fluid is returned to the host facility. The document does not discuss the separation of multi-phase fluids and the system does not include a compressor, a gas-gas jet pump, a cyclone-type phase separator, or a knock-out vessel.

Cholet et al (US 4,718,824) describes a control process for pumping either an extremely viscous fluid or a fluid containing a sizeable proportion of gas. The pump controlled by the process is a mechanical helicoid pump. There is no suggestion of a system that separates the gas and liquid phases or that uses a jet pump to boost the pressure of the gas phase. There is also no suggestion of a compressor, a gas-gas jet pump, a cyclone-type phase separator, or a knock-out vessel.

Talley (US 3,590,919) describes a subsea gas production system that allows for the production of substantially water-free and hydrate-free gas. The system includes a knock-out vessel and a low temperature gravity separator for removing liquids from the gas. However, there is no suggestion of using a jet pump to boost the pressure of the produced gas, or a

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compressor to drive the jet pump. There is also no suggestion of using a cyclone type phase separator to separate the gas and liquid phases.

Thus, the presently claimed invention provides numerous unexpected advantages over the system disclosed by Sarshar which are neither disclosed nor suggested by Sarshar et al or by any of the secondary references, alone or in combination. In addition, these unexpected advantages could not have been predicted based on these references. These unexpected advantages would effectively rebut any allegation of prima facie obviousness if one were present, and strongly support the nonobviousness of the presently claimed invention.

In view of the comments presented above, Applicants respectfully request reconsideration and withdrawal of the rejections under 35 U.S.C. § 103(a).

CONCLUSION

Should there be any questions concerning this application, the Examiner is invited to contact the undersigned agent at the telephone number appearing below. Please charge any additional fees, including any fees for additional extension of time, or credit overpayment to Deposit Account No. 11-1410.

Respectfully submitted,

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Dated: 3/3/09

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